

CLAIMS

What is claimed is:

- 5 1. An automated method for providing therapy to a patient, comprising:
detecting disordered breathing;
adapting a cardiac electrical therapy to mitigate the disordered breathing; and
delivering the adapted therapy to the patient, wherein at least one of detecting,
adapting, and delivering is performed at least in part implantably.
- 10 2. The method of claim 1, wherein at least two of detecting, adapting, and
delivering are performed at least in part implantably.
- 15 3. The method of claim 1, wherein each of detecting, adapting, and delivering is
performed at least in part implantably.
- 20 4. The method of claim 1, further comprising:
detecting patient conditions;
using a first group of the patient conditions to detect the disordered breathing;
and
using a second group of the patient conditions to adapt the therapy to mitigate
the disordered breathing.
- 25 5. The method of claim 1, wherein detecting the patient conditions comprises
detecting physiological conditions.
6. The method of claim 4, wherein detecting the patient conditions comprises
detecting respiratory system conditions.

7. The method of claim 4, wherein detecting the patient conditions comprises detecting respiration patterns.
8. The method of claim 4, wherein detecting the patient conditions comprises
5 detecting cardiovascular system conditions.
9. The method of claim 4, wherein detecting the patient conditions comprises detecting nervous system conditions.
- 10 10. The method of claim 4, wherein detecting the patient conditions comprises detecting blood chemistry conditions.
11. The method of claim 4, wherein detecting the patient conditions comprises detecting non-physiological conditions.
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12. The method of claim 4, wherein detecting the patient conditions comprises detecting contextual conditions.
13. The method of claim 4, wherein detecting the patient conditions comprises
20 detecting environmental conditions.
14. The method of claim 4, wherein detecting the patient conditions comprises detecting body-related conditions.
- 25 15. The method of claim 4, wherein detecting the patient conditions comprises detecting an interaction between therapy regimens delivered to the patient.

16. The method of claim 15, wherein detecting the interaction between the therapy regimens comprises detecting the interaction between a therapy to treat a cardiac disorder and the therapy to mitigate the disordered breathing.

5 17. The method of claim 1, wherein detecting the disordered breathing comprises detecting the disordered breathing if a respiration tidal volume falls below a predetermined threshold.

10 18. The method of claim 1, wherein detecting the disordered breathing comprises:
detecting a respiration pattern of one or more respiration cycles;
determining one or more characteristics of the respiration pattern; and
classifying the respiration pattern as disordered breathing based on the one or more characteristics of the respiration pattern.

15 19. The method of claim 18, wherein classifying the respiration pattern comprises classifying apnea.

20 20. The method of claim 18, wherein classifying the respiration pattern comprises classifying hypopnea.

21. The method of claim 18, wherein classifying the respiration pattern comprises classifying Cheyne-Stokes respiration.

25 22. The method of claim 18, further comprising:
establishing a disordered breathing index;
comparing the one or more of the characteristics of the respiration pattern to the disordered breathing index; and
detecting the disordered breathing based on the comparison.

23. The method of claim 22, further comprising adapting a sensitivity of the disordered breathing index.

24. The method of claim 1, wherein adapting the therapy comprises pacing at a rate above a normally programmed pacing rate.

25. The method of claim 1, wherein adapting the therapy comprises adjusting a pacing rate.

26. The method of claim 1, wherein adapting the therapy comprises adjusting a pacing energy of the therapy.

27. The method of claim 1, wherein adapting the therapy comprises changing a pacing mode of the therapy.

28. The method of claim 1, wherein adapting the therapy comprises changing a pacing site of the therapy.

29. The method of claim 1, wherein adapting the therapy comprises adapting an atrial pacing therapy.

30. The method of claim 1, wherein adapting the therapy comprises adapting a ventricular pacing therapy.

31. The method of claim 1, wherein adapting the therapy comprises adapting a bi-ventricular pacing therapy.

32. The method of claim 1, wherein adapting the therapy comprises adapting a multi-site pacing therapy.

33. The method of claim 1, wherein adapting the therapy comprises adapting a therapy involving non-excitatory electrical stimulation to a heart.

5 34. The method of claim 1, wherein adapting the therapy to mitigate the disordered breathing comprises adapting the therapy to mitigate apnea.

35. The method of claim 1, wherein adapting the therapy to mitigate the disordered breathing comprises adapting the therapy to mitigate hypopnea.

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36. The method of claim 1, wherein adapting the therapy to mitigate the disordered breathing comprises adapting the therapy to mitigate Cheyne-Stokes respiration.

15 37. An automated method for providing disordered breathing therapy, comprising:
detecting disordered breathing;
delivering cardiac electrical therapy to mitigate the disordered breathing;
evaluating an effectiveness of the therapy; and
adapting the therapy based on the evaluation, wherein at least one of
20 detecting, delivering, evaluating, and adapting is performed at least in part implantably.

38. The method of claim 37, wherein at least two of detecting, delivering, evaluating, and adapting are performed at least in part implantably.

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39. The method of claim 37, wherein at least three of detecting, delivering, evaluating, and adapting are performed at least in part implantably.

40. The method of claim 37, wherein each of detecting, delivering, evaluating, and adapting is performed at least in part implantably.

41. The method of claim 37, wherein evaluating the effectiveness of the therapy

5 comprises:

detecting one or more conditions associated with therapy efficacy; and
evaluating the therapy based on the detected conditions.

42. The method of claim 37, wherein detecting the one or more conditions

10 comprises detecting acute physiological responses to disordered breathing.

43. The method of claim 37, wherein detecting the one or more conditions
comprises detecting chronic physiological responses to the disordered breathing.

15 44. The method of claim 37, wherein detecting the one or more conditions
comprises detecting the one or more conditions during periods of sleep.

45. The method of claim 37, wherein detecting the one or more conditions
comprises detecting the one or more conditions during periods of wakefulness.

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46. The method of claim 37, wherein evaluating the effectiveness of therapy
comprises assessing one or more disordered breathing episodes occurring after
therapy initiation.

25 47. The method of claim 37, wherein adapting the therapy comprises providing a
more aggressive therapy if the therapy is not effective.

48. The method of claim 37, wherein adapting the therapy comprises providing a
less aggressive therapy if the therapy is effective.

49. An automated method of providing therapy to a patient, comprising:
detecting disordered breathing in the patient;
adapting a cardiac electrical therapy to mitigate the disordered breathing while
5 adjusting an impact of the therapy on the patient; and
delivering the adapted therapy to the patient, wherein at least one of detecting,
adapting, and delivering is performed at least in part implantably.
50. The method of claim 49, wherein at least two of detecting, adapting, and
10 delivering are performed at least in part implantably.
51. The method of claim 49, wherein each of detecting, adapting, and delivering is
performed at least in part implantably.
- 15 52. The method of claim 49, wherein adapting the therapy comprises:
detecting one or more conditions associated with the impact of the therapy on
the patient;
evaluating the impact of the therapy using the detected conditions; and
adapting the therapy based on the evaluation.
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53. The method of claim 52, wherein evaluating the impact of the therapy
comprises determining sleep quality.
54. The method of claim 52, wherein evaluating the impact of the therapy
25 comprises determining patient discomfort.
55. The method of claim 52, wherein evaluating the impact of the therapy
comprises evaluating interaction between therapies delivered to the patient.

56. The method of claim 55, wherein evaluating the interaction comprises evaluating the interaction between a therapy to treat a cardiac disorder and the therapy to mitigate the disordered breathing.

5 57. The method of claim 56, wherein the therapy to treat the cardiac disorder comprises bradycardia pacing therapy.

58. The method of claim 56, wherein the therapy to treat the cardiac disorder comprises anti-tachycardia pacing therapy.

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59. The method of claim 56, wherein the therapy to treat the cardiac disorder comprises cardiac resynchronization pacing therapy.

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60. The method of claim 49, wherein adapting the therapy comprises adjusting a pacing regimen.

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61. A medical device, comprising:
a detector system configured to detect patient conditions;
a disordered breathing detection system coupled to the detector system and
configured to detect disordered breathing;
a therapy control system coupled to the disordered breathing detection system
and the detector system and configured to adapt a cardiac electrical therapy to
mitigate the disordered breathing; and
a therapy delivery system coupled to the therapy control system and
configured to deliver the adapted therapy to the patient, wherein at least one of the
detector system, the disordered breathing detection system, the therapy control
system, and the therapy delivery system includes an implantable component.

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62. The medical device of claim 61, wherein at least two of the detector system, the disordered breathing detection system, the therapy control system, and the therapy delivery system include implantable components.

5 63. The medical device of claim 61, wherein at least three of the detector system, the disordered breathing detection system, the therapy control system, and the therapy delivery system include implantable components.

64. The medical device of claim 61, wherein each of the detector system, the
10 disordered breathing detection system, the therapy control system, and the therapy delivery system include implantable components.

65. The medical device of claim 61, wherein the detector system comprises a patient-internal sensor.

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66. The medical device of claim 61, wherein the detector system comprises a patient-external sensor.

67. The medical device of claim 61, wherein the detector system comprises a
20 patient input device.

68. The medical device of claim 61, wherein at least one of the detector system, the disordered breathing detection system, the therapy control system, and the therapy delivery system includes a wirelessly connected component.

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69. The medical device of claim 61, wherein the disordered breathing detection system is configured to detect a respiration pattern of one or more respiration cycles, determine one or more characteristics of the respiration pattern, and classify the

respiration pattern as disordered breathing based on the one or more characteristics of the respiration pattern.

70. The medical device of claim 61, wherein the therapy control system is
5 configured to adapt the therapy to reduce an impact of the therapy on the patient.

71. The medical device of claim 61, wherein the therapy control system is configured to adapt the therapy based on patient comfort.

10 72. The medical device of claim 61, wherein the therapy control system is configured to adapt the therapy based on sleep quality.

73. The medical device of claim 61, wherein the therapy control system is configured to adapt the therapy based on respiration quality.

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74. The medical device of claim 61, wherein the therapy control system is configured to adapt the therapy to enhance therapy efficacy.

75. The medical device of claim 61, wherein the therapy control system is
20 configured to adapt the therapy to increase a lifetime of the medical device.

76. The medical device of claim 61, wherein the therapy control system is configured to adapt the therapy to reduce interaction between a therapy to treat a cardiac disorder and the therapy to mitigate the disordered breathing.

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77. The medical device of claim 61, wherein the therapy control system is configured to adapt the therapy to a more aggressive therapy if an initial therapy is ineffective.

78. The medical device of claim 61, wherein the therapy control system is configured to adapt the therapy to a less aggressive therapy if an initial therapy is effective.

5 79. The medical device of claim 61, wherein the therapy control system is configured to adapt the therapy to a less aggressive therapy if an initial therapy does not reduce an impact of the therapy on the patient.

80. The medical device of claim 61, wherein the therapy control system is
10 configured to adapt the therapy by modifying a pacing regimen.

81. The medical device of claim 61, wherein the therapy control system is configured to adapt the therapy by adjusting a pacing rate.

15 82. The medical device of claim 61, wherein the therapy control system is configured to adapt the therapy by adjusting a pacing energy.

83. The medical device of claim 61, wherein the therapy control system is
20 configured to adapt the therapy by adjusting a pacing mode.

84. The medical device of claim 61, wherein the therapy control system is configured to adapt the therapy by adjusting a pacing site.

85. The medical device of claim 61, wherein the therapy control system is
25 configured to adapt the therapy to mitigate apnea.

86. The medical device of claim 61, wherein the therapy control system is configured to adapt the therapy to mitigate hypopnea.

87. The medical device of claim 61, wherein the therapy control system is configured to adapt the therapy to mitigate Cheyne-Stokes respiration.

5 88. The medical device of claim 61, wherein the therapy control system is configured to adapt the therapy to mitigate sleep-disordered breathing.

89. The medical device of claim 61, wherein the therapy delivery system is configured to deliver bi-ventricular pacing therapy.

10 90. The medical device of claim 61, wherein the therapy delivery system is configured to deliver atrial pacing.

91. The medical device of claim 61, wherein the therapy delivery system is configured to deliver ventricular pacing.

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92. The medical device of claim 61, wherein the therapy delivery system is configured to deliver multi-chamber pacing.

20 93. The medical device of claim 61, wherein the therapy delivery system is configured to deliver multi-site pacing.

94. A disordered breathing therapy system, comprising:
means for detecting disordered breathing in a patient;
means for adapting a cardiac electrical therapy to mitigate the disordered
25 breathing; and
means for delivering the adapted therapy to the patient, wherein at least one
of the means for detecting, the means for adapting, and the means for delivering
includes an implantable component.

95. The system of claim 94, further comprising:

means for detecting one or more patient conditions;

means for using a first group of the patient conditions to detect disordered breathing; and

5 means for using a second group of the patient conditions to adapt the therapy to mitigate the disordered breathing.

96. A therapy system, comprising:

means for detecting disordered breathing in the patient;

10 means for delivering cardiac electrical therapy to the patient to mitigate the disordered breathing;

means for evaluating an effectiveness of the therapy; and

means for adapting the therapy to enhance the effectiveness of the therapy,

wherein at least one of the means for detecting, the means for delivering, means for

15 evaluating, and the means for delivering includes an implantable component.

97. A therapy system, comprising:

means for detecting disordered breathing in the patient;

means for adapting a cardiac electrical therapy to mitigate the disordered

20 breathing while adjusting an impact of the therapy on the patient; and

means for delivering the adapted therapy to the patient, wherein at least one of the means for detecting, the means for adapting, and the means for delivering includes an implantable component.